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UNITED STATES DEPARTMENT OF AGRICULTURE

FOREST SERVICE

GRAZING

INVESTIGATIVE PROGRAM

1925

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Approved July 2, 1925.

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GRAZING
INVESTIGATIVE PROGRAM
1925

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GS
Climate and Plant Growth,
G. B. E. S.

Project: The effect of climate on plant growth.

Object: To determine (1) the part climate plays in (a) forage production, and (b) in the outcome of experimental work generally; and (2) which of the more common climatic factors are of primary importance to plant growth.

Status: Air temperature and precipitation records have been obtained during the growing season for each year since 1914 in three vegetative belts. Yearlong records are available for several years. Soil temperature, soil moisture, evaporation, air humidity, wind velocity, sunshine duration and intensity, and barometric pressure have been recorded for a number of seasons. A technical study was made in 1916 and 1917, in which the weather factors were correlated with growth of seedlings of wheat, peas, and native brome grass to determine the most influential climatic factors in each of the three zones. Results to 1917 were published in Dept. Bul. 700.

Record taking of soil temperatures, soil moisture, evaporation, air humidity, wind velocity, sunshine duration, and tipping bucket rain gage, for the growing season was started again in 1924, and are being taken along with air temperature and regular rain fall records in three zones. Records are also being obtained of the disappearance of winter snows in the spring, falling of winter snows in the fall, beginning of plant growth in the spring, cessation of plant growth in the fall, and the seasonal march of development of certain important species from the beginning of growth in the spring until its close in the fall. A number of plots, representing the more important forage species in the locality are being harvested each year to determine the annual yield.

Forage development and yield, and climatic factors will be correlated each season and one season with another to ascertain if possible the relationships.

The yield plots show that as a result of deficient moisture and other adverse climatic conditions the forage yield in 1924 was about 72 per cent of that in 1923, 63 per cent of the average annual yield since 1920, prior to 1924; and 68 per cent of the average annual yield since 1920 including 1924.

Observations and correlation with some climatic factors indicate that in regions where winter snows cover the ground until the spring thaws, herbaceous and shrubby vegetation may begin growth as soon as the snow leaves, but the main growth begins when temperature of soil surrounding the roots has risen to a point favorable for growth. Growth ceases in the fall when the soil temperature drops below a level favorable for growth, or when permanent winter shows occur.

Further Work: Fluctuations in climate cause variations in forage production on the range from year to year. They also affect the outcome of all the projects. Hence it is essential that close study of climate and its effect on forage production from year to year be made. Such a study will have direct bearing on range management in that it will afford a basis to make adjustments in stocking the range to meet the demands of the stock as well as safeguard the forage plants at all times.

It is planned to initiate record taking with regard to soil temperatures, soil moisture, evaporation, wind velocity, sunshine duration, intensity of rainfall, relative humidity of the air, and such other factors as may be pertinent. Yield plots upon which time, rate, and amount of growth may be obtained will be established, the results of which will be correlated with the climatic records.

Date of Completion: Indefinite.

Assignment: Great Basin Experiment Station in cooperation with Weather Bureau.

GS
Artificial Reseeding,
G. B. E. S.

Project: Artificial reseeding of depleted range lands.

Object: To determine suitable species, under what conditions of elevation and soil, methods and time of seeding, amount of seed, etc., required for practical success in seeding and how to graze the range during the period required for plants to become established on depleted range.

Status: Twenty indigenous and seven cultivated species have been tried out under various conditions, times of seeding, and methods of treatment since 1913. To date cultivated brome and Kentucky bluegrass have given the best results under high mountain conditions, though the latter requires 5 to 7 years to become established. These are turf farmers and do not depend upon seed for reproduction and spread. Timothy holds third place in success of establishment, but does not produce viable seed above 9,000 feet elevation, tends to run out in 5 to 7 years, and does not spread from the original seeding. Results indicate that turf formers among cultivated species are the only ones that will be maintained and continue to spread from initial planting at high elevations. Artificial reseeding of mountain lands to tame species is practical only where soil and moisture conditions are above the average.

Plants of Saacharum arundinaceum (spi. 55667) and Pentzia incana (spi. 51658) received from the Office of Foreign Seed and Plant Introduction, and planted in the fall of 1923, did not survive the winter.

Considerable success has been had with native mountain brome and violet wheat grasses as well as some of the turf-forming native wheat grasses. These species produce viable seed and spread from the original planting. The experimental work has indicated profitable methods for seed production. Seed of Agropyron spicatum, Bromus marginatus, Aira caespitosa, Festuca brachyphylla, Poa wheeleri, and four other species of Poa were collected in various parts of the West and forwarded to the Station. Part of the seed of some of these were planted in the fall of 1924. The rest of the seed will be planted in the spring of 1925. All of this seed will be planted in the nursery to begin with, to test the readiness with which these plants will grow in this region, and to determine possible seed production.

Summer seeding done at time when most of the moisture is received has given best results, though there is no marked preference over spring or fall seeding. Trampling the seed in by stock, especially sheep, appears to be the most economical and practical method of sowing seed. Sowing should be done at a time when seasonal drought, if such may occur, will least interfere with the establishment of seedlings. Total protection or deferring grazing until very late in the season for two years appears to be necessary for seedlings to become established. A manuscript has been submitted for publication.

Further Work: Tests already established will be checked from year to year. No extensive new tests with tame species will be undertaken, except as promising species may come to light.

Native species will be tried out in the nursery as rapidly as seed can be obtained. Those which show promise in the nursery will be given further trial on the range. Promising species will also be tried out to test the possibility of producing seed on an economical basis.

The cooperation of the Utah Agricultural College has been tentatively agreed to, to test out the possibilities of commercial seed production.

Date of Completion: Indefinite.

Assignment: Great Basin Experiment Station.

GS
Artificial Reseeding of
Range in Southwest

Object: To determine the species of forage plants, foreign or native, which are best adapted to grow under the varying conditions of elevation, temperature, soil, and precipitation existing on southwestern ranges; also to determine the species of trees best adapted to grow under the varying conditions encountered in south-central New Mexico for the purpose of providing a means of retarding the drifting of sand on depleted range areas and also for the purpose of providing windbreaks and shade trees.

Status: Tests of seeding slender grama, hairy grama, filaree, and Russian thistle on semi-desert range at the Jornada Range Reserve have shown negative results. Chinese elm, Chinese pistache, and evergreen athel were secured from the Bureau of Plant Industry and planted at the Reserve in 1923, and were watered regularly whenever the moisture conditions were not favorable to growth. Climatic conditions were even more severe in 1924 than in 1923, and additional plants died at the close of 1924. The elm had a survival of 13.7 per cent and had made an average annual growth of about 6 inches; the pistache a survival of 9.5 per cent but growth was about 2 inches. One, or 5 per cent, of the athel was alive and had grown about 6 inches per year. All probably would have died if they had not been irrigated.

The few plants of Phormium tenax, Kudzu vine (Pueraria thunbergiana), and Portulacaria afra which survived the extreme drought of the spring and early summer of 1923 on the Santa Rita Range Reserve died during 1924 from the cold of winter and the continued drought, even though they were watered artificially.

Experiments of cultivation of indigenous forage plants at the Fort Valley Experiment Station were made with 13 native species. Of these four show promising results, six have produced a thin stand, and three have been failures.

Future Work: Climatic conditions are generally unfavorable to the success of introduced plants, but efforts will be continued to find some hardy species which will be successful and increase the forage crop, or serve in erosion control. Whenever seeds

or plants of promising species can be secured, tests will be made on the semi-desert ranges of both the Jornada and Santa Rita Range Reserves of other important plants introduced from the semi-desert regions of South Africa, China, and other countries.

Detailed data will be recorded as to germination, growth, survival, ability to withstand the adverse climatic conditions, and the ability to hold drifting sand and prevent other types of erosion.

A working plan has been developed by the Jornada Reserve in cooperation with the Bureau of Public Roads and the New Mexico Agricultural College Experiment Station to determine the possibilities of flood irrigation for the production of emergency forage crops for supplemental feeding.

Date of Completion: Tests will be continued as promising species are available during the continuance of the investigations at the Jornada and Santa Rita Reserves.

Assignment: Matt J. Culley, Santa Rita Range Reserve; and J. D. Schoeller, Jornada Range Reserve.

GS
Artificial Reseeding
D-6

Project: Artificial reseeding of burned-over and logged-off lands, D-6.

Object: To determine suitable species and methods for reseeding burned-over and logged-off lands in the Northwest.

Status: Results on the rather dry site on the Crater Forest show no practical basis for seeding under these conditions. Results of reseeding cut-over areas where rainfall is abundant show practical success. 1924 tests on Santiam Forest lost through heavy fire which covered the area.

Further Work: Work on Crater Forest closed. Further tests will be made on the Santiam and Columbia Forests as a sub-project of the "Grazing Management of Cut-over Areas" study.

Date of Completion: Indefinite.

Assignment: D. C. Ingram.

GS
Natural Revegetation,
Deferred and Rotation Grazing.

Project: Application "Deferred" and "Deferred and Rotation" systems of grazing.

Status: The deferred and rotation grazing system was developed in the Blue Mountain region of Oregon and the results published in Department Bulletin No. 34, the Journal of Agricultural Research, Year Book, and several other articles. This project is more a line of work than an investigation, determining for specific conditions the possibilities of application of deferred grazing or deferred and rotation grazing, and the adjustments necessary from the theoretical plan.

To secure satisfactory application and the best results it is essential that Forest officers and stockmen understand the fundamentals underlying the systems and the other phases of good range management which must go hand in hand with deferred and rotation grazing.

These systems are now in application on many ranges, especially in Montana and Utah, with benefit both to range and stock. Their wider application, however, is progressing as fast as the stockmen are brought to realize their value and the necessary adjustments, if any, determined for the local conditions.

Further Work: Study of the need for and possibilities of application will be continued on those areas where grazing use demands such intensive management methods.

Date of Completion: Indefinite. A line of work.

Assignment: All Forest officers charged with the administration of grazing.

GS
Natural Revegetation,
G. B. E. S.

Object: To determine the most expedient and economical methods for natural revegetation of depleted range lands and for maintaining them at their highest productivity while obtaining maximum possible use of forage.

Status: The revegetation of depleted range lands and the maintenance of high productivity have long been considered two of the biggest problems in range management.

The work at the Station since 1914 has included the study of plant succession and rate of improvement on range that was badly depleted at the outset by the quadrat and major plot method under deferred and rotation grazing of sheep on common use range, more or less controlled season-long grazing by cattle, and on ungrazed plots. All of the plots show marked improvement of the range since 1914-1916, being the best on totally protected areas, next on the partly deferred areas, and third on season-long grazed areas. There has been improvement in the density of the stand, number and quality of species, and carrying capacity. Improvement has been more rapid in recent years, indicating that when badly depleted range finally gets "over the top" in the establishment of a few valuable plants to produce seed, improvement will then take place much more rapidly.

The results of the study of plant succession in relation to range management, including the plant indicators of overgrazing, were published in U. S. Dept. Bul. 791.

An 80-acre pasture for use in this and other projects was constructed in 1923. It will be possible to control the grazing of cattle in this pasture, and study various methods of grazing through the use of hurdles. A number of quadrats and major plots were established in 1924, but in view of the abnormally dry season the pasture was not grazed except lightly after seed maturity.

A number of plots and enclosures were established on browse range in 1924 to study the natural revegetation of birchleaf mahogany, snowberry, and bitterbrush.

Further Work: Study of the quadrat and major plot method will be continued under deferred and rotation grazing, more or less controlled season-long grazing in weed grass range - under various methods of use by the hurdle system, and on various types of browse forage on the early range. The plan is to extend the project until eventually all of the important types of range in the vicinity of the station will be under study. Some of the less important plots in the higher zones that are not serving a very useful purpose will be abandoned to give time for more useful study elsewhere.

Date of Completion: Indefinite.

Assignment: Great Basin Experiment Station.

GS
Natural Revegetation,
Plant Vigor, G. B. E. S.

Sub-Project: The relation of season, frequency, and degree of harvesting to the vigor of the vegetation.

Object: To determine the effect on the vigor of various forage plants of harvesting at different seasons, intervals, and degrees of use, and to work out methods of grazing, based on them, to improve and maintain the range, and at the same time obtain the maximum use of the forage.

Status: The first work in this sub-project was begun in 1917, and carried on for three seasons with a few species, under three methods of harvesting. In 1920 it was enlarged to include in all nine species and 24 different seasons and frequencies of harvesting. Work with these was continued throughout 1920, 1921, and 1922. Beginning in 1923, the number of methods was reduced to 9 different seasons and frequencies, and one method to study effect of cutting at different height intervals was added. In 1924 plots of Bromus polyanthus, Agropyron violaceum, and Geranium viscosissimum were added to include 11 various methods, involving time, frequency, and height of cutting. These include further check and study of methods which were indicated by the earlier work to be worthy of such consideration. This new work is based on the study of the yield from plots, rather than from groups of individual plants.

One of the phases of the earlier work was to determine the effect upon the chemical composition of the herbage, and upon the roots of several different methods of harvesting.

The project was extended to substitute actual grazing for the cutting method in 1923. Three similar and adjacent areas of 20 acres each were fenced in 1922, and have been grazed by sheep for the past two seasons. The grazing of the three paddocks, together with permanent and panel enclosures, makes possible the study of seven different times and frequencies of grazing.

A wall chart was prepared covering the first three years' work, and report embodying the results up to and including 1922 has been submitted for publication.

Further Work: The cutting of the plots and the grazing of the paddocks as begun in 1923 and 1924 will be carried on during 1925. No changeor addition is contemplated at the present time.

The proposal was made in 1923 to try out on the range two systems of grazing that have shown promise under the cutting methods. These are (1) grazing lightly at time of vegetational readiness, followed by another cropping just after seed maturity, and (2) grazing lightly at time of vegetative readiness, and again approximately six weeks later. Lack of time, the unusual climatic conditions, and uncertainty of sheep allotments upon which to try the methods, prevented undertaking this work in 1924. It should be kept in mind, however, and the test tried out as soon as time and suitable conditions will permit.

Date of Completion: Indefinite.

Assignment: Great Basin Experiment Station.

GS
Natural Revegetation,
Utilization, G. B. E. S.

Sub-Project: The proper degree of utilization of range lands.

Object: To determine (1) proper degree of utilization in the fall, (2) time when grazing should be discontinued in the fall, (3) standards for judging utilization, and (4) percentage of good forage that should remain at time of seed maturity each year for natural revegetation.

Status: This project will be conducted largely on an actual range basis. A pasture for this purpose was built in 1923. Plans were to get the study under way in 1924, but this was postponed another year on account of the drought conditions which prevailed in 1924. The necessary plots and quadrats were established and the quadrats mapped in 1924.

Further Work: Plans are to get the project under way according to the working plan in 1925.

Assignment: Great Basin Experiment Station.

GS
Natural Revegetation
(Biological Study of
Plant Succession)
G. B. E. S.

Object: (1) To develop certain field tests based on the character of the soil by which the suitability of the soil to support the various stages in plant succession may be predicted with a high degree of accuracy and (2) to ascertain the relationship of osmotic concentration, certain salts and electric conductivity of cell sap of various range plants to (a) their position in the successional scale and (b) palatability and forage value.

Status The working plan was prepared in 1919. Very little work has been done, owing to insufficient funds and personnel. That done consisted of three weeks' work in 1921 in determining the osmotic concentrations of some of the indicator species and a few days of similar work in 1924.

Further Work: Fulfillment of the proposed plan of this project cannot be realized until the Station funds and personnel are increased. It is proposed, however, to devote a limited amount of time next season to the study of osmotic concentration, chemical composition and electrical conductivity of the cell sap of some of the more significant plants in the vicinity of the Station, and to correlate these data with site, type, palatability, etc., providing the cooperation of Dr. Harris of the University of Minnesota is obtained.

Use of Results: The working out of this problem should go far to determine (1) the potential value of range areas, (2) management necessary to stimulate succession in the way desired, (3) the length of time required for complete revegetation, (4) the use of the cell sap method in revegetation studies in range investigations, (5) the relation of sap concentrations to palatability.

Date of Completion: Three years after work is actively undertaken.

Assignment: Great Basin Experiment Station.

GS
Natural Revegetation
Spring-Fall Range
U.S.S.E.S. & G.B.E.S.

Project: Natural revegetation for maintenance and improvement of spring-fall range.

Object: To determine, for spring-fall range, the details of the deferred and rotation system of grazing, involving (1) the rate of improvement of depleted range under the systems; (2) the frequency with which grazing should be deferred to maintain range in good condition and to determine the trend of plant succession and the plant indicators of range conditions.

Status: The grazing of paddocks 1 and 6 and of the ram pasture, and the establishment of quadrats and major plots in these areas and upon range having various degrees of depletion, are designed to give information for the above headings. The grazing of the paddocks is as follows:

Paddock No. 1 - Do not graze at all during spring for two years, beginning in 1923, or until a maximum forage cover has been established. Graze fully but not destructively in the fall.

Paddock No. 6. - Graze in both spring and fall in alternate years and only in fall every other year. Paddock was not grazed until the fall of 1923 and in both spring and fall of 1924.

Ram Pasture - This paddock has been grazed very lightly during the spring, or not enough to interfere materially with seed production for the past two years. It had been quite closely grazed season long by rams prior to 1923, and much of the vegetation had been over-grazed. Deferred grazing will, in all probability, be at least partially deferred until the range is restored.

Major plots and quadrats have been established in each paddock in the ram pasture within totally protected areas and upon range at varying distance from water where there will be more or less close grazing near water. Records of animal days feed are being maintained for Paddocks 1 and 6. An intensive reconnaissance has been made of the two paddocks. These records will give comparative data for the several methods of handling the range as to the increase or decrease in carrying capacity and the change in the composition and density of the vegetation.

Checks that will give information to fit into this project will be obtained whenever possible.

Work for 1925: Whether or not grazing will be deferred another year in Paddock 1 will depend upon conditions as found in the spring of 1925. In view of the drought in 1924, however, the chances are that it will be advisable to continue it another year.

Deferring grazing again in the ram pasture will be controlled by the needs of the pasture in handling the sheep.

Quadrats which were charted in 1923 should be remapped in 1925.

Records of number of animal days, feed, degree of utilization, etc., will be maintained.

Assignment: U. S. Sheep Experiment Station and Great Basin Experiment Station in cooperation.

Copy

GS
Natural Revegetation
Utilization
Spring-Fall Range
U.S.S.E.S. & G.B.E.S.

Project:

The degree of utilization of spring-fall range.

Object:

To determine for spring-fall range (1) the degree of grazing that may be permitted in the spring and in the fall, (a) without injury to the forage, (b) and to have an adequate amount of forage available for use during both the spring and fall seasons; and (2) the effect of time and degree of use upon the pasture gains of sheep.

Status:

(1) (a) The grazing of Paddock 7, which contemplates light use in the spring but heavy use in the fall, and of Paddocks 2 and 8, which contemplate fairly heavy use in the spring, is designed to give information as to the effect of closeness of use in the fall and spring respectively. The plant succession and animal days feed data from these paddocks, when compared with corresponding data from the other paddocks grazed differently and from the protected areas, should show the effect, if any, of close utilization in the fall and spring.

(1) (b) The main growth of forage in the spring-fall range country where the tests are located takes place during the spring growing season. This season is followed by a period of more or less uncertain rainfall which may or may not be sufficient to promote growth of the forage after the spring season. Forage for use in the fall consequently is dependent upon summer rains when the spring growth is utilized fully prior to the summer grazing season, or upon the reservation of some of the forage produced in the spring, for fall use. The results from the grazing of Paddocks 2, 3, 6 and 8 will show the extent to which growth following the spring grazing season can be depended upon for use in the fall, or if it will be necessary to restrict grazing in the spring to provide a supply of forage for fall use.

(2) How well sheep do in the fall on spring-fall range, either in the case of lack of late rains to promote new growth or when such rains occur, appears to depend to a greater or less extent upon the amount of old, dry forage remaining on the range when fall use begins.

The amount of such old dry forage on the range, in turn, depends upon the degree of utilization in the spring, and to some extent upon the degree of use during the previous fall. Comparison of entrance and leaving weights of the sheep during the fall period grazed in the paddocks used quite heavily in the spring, with corresponding weights for those grazed in paddocks less heavily used during the spring, will give information on this point. Breed of sheep may, however, have a bearing on the gains or losses during the fall season, and this factor will be taken into account.

Results:

The results for the last two years indicate that in good years such as 1923 there will be sufficient growth following the spring grazing season to afford an ample forage supply for the fall grazing period. In that year late rains were ample to make available considerable green feed during the breeding season. In 1924, however, when the winter, summer and fall precipitation was all somewhat below average, the sheep were forced to depend for fall feed mainly upon the spring growth that was left after the spring grazing season.

The ewes were weighed in the fall of 1924 at time of entrance, and again on leaving the paddocks. They were in the paddocks a total of 37 days. The following results were obtained:

The smallest losses in weight, from 2.42 pounds to 4 pounds, were among Corriedales and crossbreeds grazed in the paddocks which were used the heaviest during spring. One bunch of Columbias, grazed in a paddock that was not grazed at all during spring, lost 5.05 pounds. Another bunch of Corriedales grazed in a paddock (No. 9) that had been quite closely grazed during the summer, lost 4 pounds. Rambouillets lost 6 to 7.6 pounds, apparently without reference to the condition of the forage. A group of Columbias lost 10.38 pounds, and a group of "B's" lost 8.70 pounds per head in paddocks that had been only lightly grazed during the spring. Degree of use during spring and breed of sheep both appear to have had a bearing on the losses during the fall season. Corriedales held up the best, Columbias second, and Rambouillets third. The sheep in paddocks used the heaviest in the spring held up better than those grazed in paddocks lightly used in the spring, except in the case of Paddock No. 9, where the slightly higher losses were due to close grazing.

Further Work:

The quadrats in each of the paddocks should be remapped in 1925.

Weighings will be made and records of utilization obtained for 1925 as in 1924.

Assignment:

U. S. Sheep Experiment Station and Great Basin Experiment Station.

GS
Natural Revegetation
Range Reserves

Status: A practical system of deferred grazing has been in application on 11 of 13 pastures at the Jornada Range Reserve for ten years. A comparative study has been made of results secured under different methods of grazing and total protection on the Reserve and on adjoining public domain range where grazing is unregulated. Detailed observations have been made of methods of reproduction of the important forage species and a number of large quadrats were established and clipped beginning in 1920 to determine the effect of various degrees of cropping at various times of the year. A study of growth habits and degrees of grazing upon blue and hairy grama grass was initiated in 1921. Study of the life history, rate of growth, reproduction, methods of cutting, etc., of soapweed production were started in 1918, and have been continued since. The investigations of periodical burning of tobosa grass areas were extended to additional areas in 1919, and areas examined each year since. Results obtained up to 1917 were published in Bulletin 588, and those up to 1920 in Bulletin 1031. Progress reports have been submitted each year since.

During the past ten years five have been below normal and only two materially above. 1924 concluded the fourth successive dry year and proved to be the worst since 1917. Growth, particularly on the grama type, was very scant. Where grazing was partially deferred during the main grazing season, depreciation on grazed range was least during drought and best results have been secured in recovering and maintaining productivity.

On the Santa Rita Range Reserve in Arizona, deferred grazing, conservative yearlong stocking, moderate grazing, and protection from grazing are being compared with unregulated grazing on adjacent ranges. The results show remarkable recuperation of the vegetation following drought and its ability to maintain a maximum stand, and demonstrate the value of the methods employed on the Reserve over that on the outside. Overgrazing causes deterioration in stand, full use when properly adjusted has no detrimental effect on most species on this range and may increase density of certain valuable ones, moderate grazing is not necessary to maintain most species, and proper full use usually increases or maintains most of the valuable ones better than total protection from grazing. Deferred grazing, especially during July which is the main growing period, has increased production and carrying capacity. Clipping work to determine effect of

frequency and time of grazing of important species has shown that all the gramas studied produce the greatest volume of forage when clipped once at the end of the growing season, next when clipped six inches above the ground at monthly intervals, and the volume decreases with more often and more severe clipping during the growing season. With Curly mesquite, a stoloniferous grass, the volume produced is practically the same under all methods of clipping. The study of methods of reproduction of individual species shows that propagation by vegetative methods is far more important on this range than reproduction from seed. Studies are being conducted, in cooperation with the Biological Survey, Carnegie Institution, and Arizona Agricultural Experiment Station, in rate of recovery of range where rodents have been exterminated.

Further Work: The detailed quadrat studies will be continued. Careful observations for the areas as a whole will be made to supplement the detailed data secured from the chartings. The studies will be extended and strengthened by the establishment of additional quadrats, additional small protected areas, and small pastures where definite control of the stock can be exercised. The further recovery of the different types of vegetation from the detrimental effects of the drought will be carefully studied. The observations to determine more accurately the particular ways in which the forage plants reproduce will be further extended at the two Reserves. The results of the Santa Rita Reserve experiments have been prepared for publication this year.

The clipping experiments will be extended at both Reserves. The results from clipping tobosa grass under different methods will be undertaken at the Jornada this year.

The importance of soapweed as a supplemental feed during drought periods requires that the soapweed investigations be further extended. The investigation of utilization of summer range types also needs further extension. Through a close correlation of all phases of the problem the rate of recovery of depleted ranges and maintenance of normal carrying capacity under the different methods of range management will be determined.

Date of Completion: The great variation in vegetative growth due to variation in rainfall on these two Reserves in different years, and the necessity for meeting the requirements of the stock, have resulted in departures

Date of Completion: The great variation in vegetative growth due to variation in rainfall on these two Reserves in different years, and the necessity for meeting the requirements of the stock, have resulted in departures from any previously arranged intensity of grazing. These difficulties must be met in practical management, and it is desirable therefore to meet them in the experimental management as they occur through a period of years. As a consequence, this project will be continued as long as the Reserves are under experimental management. The plan of grazing will be slightly varied between pastures of the same Reserve in order to secure data on all possible phases of the problem.

Assignment: J. D. Schoeller, Jornada Range Reserve: Matt J. Culley, Santa Rita Range Reserve; in cooperation with J. R. Chapline.

GS
Natural Revegetation,
Snakeweed

Object: To determine reasons for snakeweed (Gutierrezia sphaerocephala) invasion of the black grama type, its possible value in the type, and the effect of competition of snakeweed and black grama.

Status: Plots established in 1924, root systems studied in 1925, careful observations made on all phases of project.

Drought and overgrazing play important parts in increase of snakeweed on the black grama type. Many snakeweed seedlings have come in the last two years on range where the black grama stand has been thinned to below 2/10 density. It was rather difficult to find healthy snakeweed plants on areas where the grama occurred in a good stand and made a good growth. Under such conditions there is considerable intermingling of grama roots 4 to 5 inches beneath the soil surface. On numerous areas the snakeweed is dying. Beetles and decay have attacked the roots of most plants over 12 inches high. While grama root systems average about 8 inches in depth and seldom reach 12 inches, snakeweed seedlings averaging 4 inches in height had tap roots of 17 inches. Root systems of larger plants averaged 24 inches in depth. On badly depleted, sandy areas snakeweed tends to reduce wind erosion.

Further Work: Will be continued along same lines.

Date of Completion: When conclusive data have been secured.

Assignment: Jornada Range Reserve.

GS

Natural Revegetation

D-1

Object: To determine what method or methods, system or systems, and intensity of grazing will maintain the vegetation of the Northern Rocky Mountains in the highest state of productivity or will increase the stand if depleted; to study growth habits and requirements of principal species.

Status: This project has been carried in the past largely as an administrative project to secure the application of principles developed in other places to the Northern Rocky Mountain conditions. Last summer active work was undertaken on the Madison National Forest, Montana, to determine fundamental data relating to the habits of growth, seeding, longevity, and life history of the principal forage species. This work is closely connected with the other studies on the Madison and the same set of quadrats and enclosures are used. In addition, specific quadrats and transects have been located to complete the study.

Further Work: The quadrats will be recharted and observations will be made on individual plants as well as on general types. It is also proposed to make a study of plant succession under natural conditions as well as in habitats where grazing is an important ecological factor. In so far as possible tests will be made of the principles evolved.

The results obtained will be a basis for the determination of range conditions and proper methods of management. With these data available the condition of a range can be accurately judged and the point of highest productivity determined.

Date of Completion:

The work will be continued on the Madison for at least two years and then it may be transferred to some other Forest. The study of natural revegetation will be continuous.

Assignment:

W. G. McGinnies in cooperation with local Forest officers.

GS
Natural Revegetation,
D-2.

Status: A project was initiated to determine the influence of deferred and rotation grazing on cattle ranges on the Medicine Bow Forest in 1914. Two compartments were fenced; one was grazed season-long by cattle, and the other only after seed maturity for the first two years; then the order was reversed for the next two years and this system of rotation has been continued each two years since. During the first three years there was only a slight increase in amount of surface covered by fescue and bluegrass and no increase in other vegetation. Since 1916 there has been a marked increase in all the vegetation, especially grasses and sedges. Results indicate that during the first few years the benefit to the range which resulted lay in recovery of the vitality of the plants and that this increase in vitality was necessary before the marked increase in stand later took place.

Each Forest in the District (except Nebraska and the Lake States) was required to establish at least five fenced plots with chart quadrats inside and outside. This was accomplished except in a few instances where the work will be completed by early 1925. On a few Forests more than the five were established.

These plots will be used to study the development of the vegetation and its maintenance under the management being applied to the range. The benefit of this work is largely in indicating definite need for change of management, where retrogression in the stand or slow recuperation of depleted areas is indicated.

Further Work: It is planned to continue the observations and rechart the quadrats at intervals of two to five years to determine more definitely the trend of vegetation in this region under total protection, deferred and rotation grazing, and other types of management. The ultimate objective is to have one such plot in each major type of range on each ranger district.

Date of Completion: Indefinite.

Assignment: Forest officers of the District in cooperation with Inspector of Grazing in District 2.

GS
Natural Revegetation
D-3

Object: To determine proper methods for handling the various southwestern forage types on a sustained production basis. More definite knowledge is especially needed concerning such fundamental principals as:

(1) Normal forage composition of various sites;

(2) Plant changes due to varying intensities and methods of grazing compared to protection;

(3) Density changes due to overgrazing;

(4) Rate of recovery of abused ranges.

Status: Five plots about 2 acres in size on the Coconino Forest in mixed bunchgrass and grama types were fenced in 1912. Five-metre quadrats were established within each area and five on adjacent range outside. All quadrats charted in 1912, 1913, 1914, 1921, and 1924 - a few in 1917. Progress report by Talbot dated February 9, 1923. The following chief indications were noted: Grama under protection declines in stand with competition of ungrazed bunchgrasses, maintains its stand under light to full grazing use and may even gain under latter, but succombs to long-continued overgrazing. Bunchgrasses gained under light grazing or total protection, but lost under full use of the type and decidedly under overgrazing. Black Sporobolus resisted overgrazing the best of any species studied. "Weeds" and minor grasses exhibited varied behavior by species. In one instance total density of all vegetation increased more under light grazing than under total protection.

The 1924 records were taken during a drought and show that drought may cause a reduction of from 40 to 60 per cent of the range forage crop even on protected areas. This is the combined result of killing of parts of tufts and of decreased vegetative growth. The reduction in density increases as the degree of grazing increases. Blue grama made very little vegetative growth. Weed growth was not so seriously affected.

The Tonto investigations are reported under the "Utilization and Management of Browse Range, D-3" project.

A mimeographed report, "How to Judge Southwestern Range Conditions" by M. W. Talbot was prepared and sent to the field.

Further Work: The Coconino plots will be charted at intervals, and work will be continued on the browse types in connection with the study of the utilization and management of browse range.

Assignment: C. K. Cooperrider; E. [illegible] Nelson (report).

GS
Natural Revegetation
D-4

Object: To determine time and methods necessary to naturally revegetate badly depleted ranges of the intermountain region, and to determine methods necessary to maintain desirable forage stand once secured.

Status: The past quadrat and other work on the study was checked up in the field during 1924. Such new plots were established and observations undertaken as will satisfactorily solve the main questions of improvement and maintenance of the important range types on the Forests of the intermountain region.

Date of Completion: Indefinite.

Assignment: J. O. Stewart and administrative officers on Forests of District 4.

GS
Natural Revegatation
D-6

Object: To determine the natural annual development of the main plant species, the plant succession and proper forage management under grazing and complete protection from grazing.

Status: Enclosures were established on representative ranges of Forests of the District, especially the Crater, Ochoco, Deschutes, and Whitman, and recovery under total protection as against the type of management being applied is being studied. Local adjustments have been made in accordance with the findings and application of results to other ranges studied.

Further Work: The necessary observations on the Forests will be continued as time permits.

Date of Completion: Indefinite; more in the nature of a line of work.

Assignment: Technical grazing men and other Forest officers administering grazing in the District.

GS

Economic Importance, Distribution, and Natural Habits of Range Plants, D-1 to D-8.

Object: Collection and analysis of economic, ecological, phenological, and other data on growth and growth requirements of National Forest range plants, together with the development of workable herbaria of these plants with their data.

Status: The proper use and management of any range area depends to a large extent upon knowledge of the forage value under different conditions, other economic significance, growth requirements, and life habits of the plants which make up the vegetative cover on that range.

Work started in 1907. Nearly 50,000 plants and accompanying data have been collected in the field by upwards of 1,000 collectors, including range investigative and other grazing specialists, range reconnaissance parties, and administrative men on important grazing Forests. These have been identified by the experts of the Bureau of Plant Industry. Between 85 and 90 per cent of the plants collected are represented in the Washington office herbarium, representing approximately 6,000 species and varieties, belonging to over 1,000 genera.

Special observatiins on palatability, forage value, and other factors have been made at the Great Basin Experiment Station, Santa Rita and Jornada Range Reserves, by other investigative men and technical men assigned to Forests. Preliminary tables of palatability are being compiled by Forests and groups of Forests in each District. Manuscript analyses ("economic notes") are available for about 3400 species and varieties.

Brief primers of the more common species have been worked up for Districts 3 and 4. A booklet containing notes for the grass species was printed in 1914, and Bulletin 545, ("Important Range Plants,") was published in 1918. A general bulletin on important browse plants has been presented for publication. Manuscript is well under way for a general bulletin on "weeds" as range forage and of a bulletin on southwestern range plants.

Special effort is being given to have Rangers become familiar with the more important forage plants of their Districts.

Further Work: Collections will be continued, special attention being paid to more thorough observations. Further compilation of palatability data will be made and lists revised as more data become available. Collection and analysis of economic and other data will be continued with the view of submitting the material for publication as rapidly and in such sequence as may seem desirable, and bulletins now under way will be pushed to completion.

Assignment: W. A. Dayton, Ivar Tidestrom, and grazing men in Districts, and at experiment stations. Mr. Shoemaker is cooperating in the preparation of the general "weed" bulletin, and Mr. M. W. Talbot (now of the Bureau of Plant Industry) in the bulletin on southwestern range plants.

GS
Period Studies,
D-1

Object: To determine for Northern Rocky Mountain conditions vegetative readiness; factors affecting first growth of vegetation; time necessary for species to make a good vigorous growth; influence of grazing before vegetative readiness; factors that determine proper closing of season and the effect of cropping second growth. Management and handling of stock on the spring ranges.

Status: A few quadrats have been located on experimental ranges of the Madison Forest, Montana. All available climatological data for the region assembled and studied. Administrative study of the seasons on the Helena Forest made in 1924.

Further Work: Temporary enclosures and additional quadrats will be established on Madison and Custer Forests in 1925. Climatic stations will be established in 1925 on these Forests in cooperation with the Weather Bureau. Administrative studies to determine proper seasons of use in accordance with the principles developed will be made on all Forests as fast as available time will allow or necessity demands.

Date of Completion: Indefinite.

Assignment: W. G. McGinnies and administrative officers of the District.

Period Studies,
Districts 2 to 6.

Project: Determination of date when grazing may be allowed upon each range unit without injury to range or livestock.

Object: To correlate opening of grazing season and management of stock with time of vegetative readiness of range for grazing.

Status: Much still remains to be done in the way of phenological observations on each Forest for correlating these data with seasons of growth and proper time of use. Study was made of the ranges on the Uinta Forest in 1919 and a management plan developed to secure proper time of admitting and distribution of stock. Studies have also been made on most of the Forests in District 4, and necessary changes made in opening of the grazing season. Other special studies have been made on the Montezuma Forest in Colorado, the Crater, Ochoco and Whitman Forests in Oregon, the Wenatchee Forest in Washington, California Forest in California, and the Santa Fe Forest of New Mexico. Seasons have been adjusted to a proper basis on many other Forests. The date of opening at the boundary of the Forest is but one phase of the problem; proper distribution of stock with respect to various exposures and elevations is of equal importance.

Further Work: Observations to determine the date of vegetative readiness of the range at various elevations and on different exposures and methods to secure proper management of stock in accordance therewith will be extended to other Forests in all Districts, and will be continued until time of grazing and time of vegetative readiness of range for grazing have been correlated upon all the Forest ranges. This is a line of work rather than a specific project and is essential to proper range management.

Assignment: Inspectors of grazing, grazing examiners, and all Forest officers administering grazing in Districts.

GS
Period Study,
G. B. E. S.

Project: Range readiness, and the length of the grazing season on mountain grazing lands.

Object: To determine (1) the effect of continued early use on the vigor and production of the forage, (2) the time at which stock may be admitted to the range without injury to the forage from too early use, (3) methods of determining date of range readiness, (4) the effect of continued close cropping from the time of seed maturity to the end of the growth period in the fall, (5) the time that grazing should be discontinued in the fall.

Status: The investigations show that there will be a material decline in productivity of forage if grazed prior to the time the principal grasses and weeds are about six inches high, but after that stage of development is reached the forage is ordinarily able to withstand normal stocking. Standards based upon the aspect and development of the forage have been devised for judging the date of vegetational readiness. These standards have been tried out for the past few years in District 4, and found to be thoroughly applicable for mountain range. A publication concerning the work up to 1922 has been submitted for publication.

Checks have been made for the last two seasons to ascertain the variation in the date of vegetational readiness, one year with another, because of fluctuations in climatic conditions.

A series of plots were established in 1921, including three species to ascertain the effect of close grazing in the fall as it pertains to the close of the grazing season. Two additional plots were added to the study in 1923, and three more in 1924. The results of the cutting tests started in 1921 indicate that Agropyron violaceum and Poa nevadensis decline in vigor and yield if grazed closely from the time of seed maturity until growth ceases in the fall, but that Geranium Viscosissimum suffers little or no injury. Additional study is thought necessary to confirm these tentative conclusions.

Date of Completion: Indefinite.

Assignment: Great Basin Experiment Station.

GS
Period Study
Spring-Fall Range
U.S.E.S. & G.B.E.S.

Project: Range readiness on spring-fall range.

Object: To determine for spring-fall range (1) the effect of continued early use on the production of forage; (2) the time at which grazing may begin in the spring without injury to the range from too early use; (3) methods of judging the time of range readiness.

Status: Work on this project was started in the spring of 1923. The grazing of Paddocks 2, 3, and 8 is planned to give information for this project. It is as follows:

Paddock 2 - Begin grazing in the spring as soon as forage begins to grow, and continue to graze as fully as possible until sheep are removed to summer range (Approximately June 15). Utilize remaining forage in the fall.

Paddock 3 - Begin to graze as early as forage begins growth in the spring and utilize quite heavily until growing season has advanced twenty to twenty-four days, then discontinue grazing until fall when it should be used fully but not destructively.

Paddock 8 - Start grazing in the spring when forage is about six inches high and grasses beginning to head out, and continue grazing until sheep are taken to summer range. Graze again in fall, fully but not destructively.

A major plot 16½' x 16½' and a meter quadrat were established in each paddock in 1924 and 1923 respectively. Protected plots with quadrats for check have also been established. Records of time of use, number of stock and degree of utilization are being maintained.

By this method, information comparing season-long spring use beginning with inception of growth, short-time spring use beginning with inception of growth, season-long spring use beginning after growth is well started and ungrazed range will be obtained. The grazing records and quadrat study will show effect of each method upon forage production and density and composition of forage.

The paddocks have been grazed according to schedule for two years. Plots and quadrats have been established and mapped, and an intensive reconnaissance made for each paddock.

Further Work:

Grazing of the three paddocks will be continued through 1925 as in the past two seasons. The quadrats are due for re-charting during the season of 1925. Beginning not later than 1926, and in 1925 if possible, records of the development of the vegetation at time of vegetational readiness will be started.

Date of Completion:

Project should be continued as started for two or three more seasons.

Assignment:

U. S. Sheep Experiment Station and Great Basin Experiment Station.

GS
Period Studies
Range Reserves.

Status: The study of effect of utilization at different seasons has been under way with openable enclosures in certain types at both the Santa Rita and Jornada Range Reserves for the last three years.

The tentative indications with black grama on the Jornada are as follows:

(a) Early grazing in the summer growing season reduced the final number of flower stalks and forage production.

(b) The maximum number of flower stalks was produced during the first month of the growing season.

(c) Grazing during the growing period tends to increase the number of horizontal flower stalks.

(d) Opening an area to grazing 15 days after growth starts is apt to result in reducing the stand even though it is properly grazed.

(e) Later opening of the season up to the close of the growing period tends to favor an increase in stand if range is not overgrazed.

(f) Losses in stand on areas opened to grazing 15, 30, and 90 days after growth started and left open the balance of the year were undoubtedly due to overgrazing during the grazing year 1923-24 rather than improper seasonal use during the growing season of 1923, since areas opened at the same time, but which were closed after proper use had been obtained, showed increases or maintenance of stand.

The study of seasonal use of the mesa type on the Santa Rita Range Reserve has been complicated by drought and a slight overgrazing which has made work so far indefinite.

Further Work: Additional work is needed before definite conclusions can be drawn. Additional enclosures will be established in other types at both Reserves.

Assignment: Matt J. Culley, Santa Rita Reserve; and J. D. Schoeller, Jornada Range Reserve.

GS
Carrying Capacity,
Range Reserves.

Project: To determine carrying capacity of semi-arid range in southern New Mexico and southern Arizona, and the influence of the many factors affecting it.

Status: Records of the time of grazing and animal days feed furnished by each of 13 pastures on the Jornada Range Reserve have been kept for 9 to 12 years. The greater part of the area has been classified into range types, so as to determine carrying capacity as a whole for the Reserve and carrying capacity by large range types. A check reconnaissance was made in 1924. Especially the comparative carrying capacity of range under fenced control and under different methods of proper range management, and range not under fence, is being studied. Data for 3 years were published in Bulletin 588, and for 7 years in Bulletin 1031.

The pastures at the Santa Rita Range Reserve have been under observation for 9 to 16 years. Carrying capacity under different types of management for foothill semi-desert mesa and desert types have been studied and especial emphasis has been given to the influence of the many factors which affect carrying capacity. The data have been prepared in manuscript form for publication.

The droughts of 1916 to 1918 and 1921 to 1924 on the Jornada, and the six years below normal in the last nine at the Santa Rita, have shown the real significance of drought as a factor in carrying capacity over a period of years. The reduction in carrying capacity as compared to good years may be as great as 50 per cent over extensive areas, and even greater in small types, due to drought alone. The investigations have clearly demonstrated that overstocking in connection with drought causes considerably greater reduction in the carrying capacity of the range. The range within the Reserves, properly stocked and handled under proper management methods, (the number of stock on the Jornada was reduced one-half from stocking in good years; no reduction in grown stock has been necessary on the Santa Rita), has carried more stock through the series of years than unregulated range outside, and is now in better condition to carry a greater number on an equal area than the outside ranges. In addition, more stock were carried on range handled under deferred grazing than on similar range under continuous yearlong use. On the Santa Rita Range Reserve the increased carrying capacity from deferred grazing has been approximately 20% for foothill pastures and 10% for the more arid mesa pastures.

Further Work: The investigations as outlined above will be continued and will be intensified as rapidly as facilities for a more specific study of carrying capacity by range types are provided. Special emphasis will be placed on the study of the influencing factors. Observations will be extended to cover more range throughout southern New Mexico and southern Arizona. The results of these studies eventually will be combined with carrying capacity data from District 3.

Date of Completion: Continuous as long as the Reserves are under experimental management.

Assignment: Matt J. Culley, Santa Rita Range Reserve; and J. D. Schoeller, Jornada.

GS

Carrying Capacity,
Montana.

Object: To determine forage-acre requirement for cattle and sheep; factors influencing carrying capacity and forage-acre allowance; proper utilization; amount of use of range consistent with perpetuation of important forage species; the degree of utilization which should be obtained under different systems or methods of management and the relative palatability of important species under all conditions.

Status: Quadrats established on Ford Creek area, Lewis-Clark in 1918, recharted in 1924, and results of study checked. Quadrats located on Madison Forest in 1915 rechecked. Thirty more located in 1924, and series of temporary and permanent enclosures constructed. Observations on utilization and palatability made. A pasture comprising 4292 acres on the Custer National Forest was covered by intensive reconnaissance in 1924. A site for study previously covered by reconnaissance has been located on the Beaverhead.

Further Work: The work will be continued in a very thorough manner on the Madison. More quadrats and enclosures will be established and the existing quadrats recharted. The range reconnaissance of the experimental areas to be rechecked in 1925. The Custer investigations will be started during the 1925 grazing season and work will be commenced on the Beaverhead as soon as funds are available. The work will be extended to other Forests to cover all main vegetational types as fast as the personnel can handle the work and funds become available.

Date of Completion: The work on the Madison will be completed in 1926 or 1927, but the charting of a small number of typical quadrats and general rechecking of results will be continued at intervals of several years. On other Forests indefinite.

Assignment: W. C. McGinnies (Madison and Custer), Glen Flathers (Custer); technical grazing men assigned to Forests and other properly qualified men.

GS
Carrying Capacity,
(Burned and logged areas)
D-1

Object: To secure a definite basis for future management of the western ranges of District 1 to determine the rate of decrease of carrying capacity necessary during succeeding years on cut-over and burned-over ranges due to cutting and restocking of the original timber type with resultant decrease of forage and to determine the amount of use which can be obtained from these ranges without injury to timber growth.

Location: Several areas are available for this study on the Cabinet, Clearwater, and Lolo Forests. The exact location of the study area to be determined later.

Status: The general survey of the grazing situation on the western Montana and northern Idaho Forests by Supervisor A. A. Simpson during 1924 showed additional need of such a study and also furnished some basis for further work.

Further Work: Work on this project should be undertaken as soon as a qualified man is available to start the work. The work could then be continued by a technical local officer under the supervision of the Office of Grazing Studies and in cooperation with the Office of Forest Management.

Date of Completion: Indefinite.

Assignment: Studies man attached to the District Office with the assistance of local Forest officers.

GS
Carrying Capacity,
All Districts.

Status: In addition to the more fundamental work started this year in Montana, numerous tests for carrying capacity of range for both sheep and cattle have been made on Forest ranges. Range for four bands of sheep were under detailed observation on the Deerlodge Forest in 1912-13, three bands in 1914, two bands in 1915-16; eight bands in 1912-13 on the Madison Forest, six in 1914, and four in 1915; three bands on the Targhee in 1913-14; One band on the Manti in 1913, three in 1914, and two in 1915-16; two bands on the Caribou in 1913-14, three bands in 1915, and five in 1916; two bands on the Fillmore in 1916. Range for 250 cattle was under observation on the Lewis and Clark in 1914-16, and further study made on range for 750 cattle in 1918 and 1924, and reports submitted. Observations were made on a number of cattle range pastures in District 3 in 1914, 1915, and since 1920.

Since initiation of grazing reconnaissance in 1911, forage acre data have been collected for approximately 23 million acres. Checks are being made by observations and use in actual grazing management of these estimates and adjustments made when necessary. Range appraisals initiated in 1921 will secure valuable checks on data obtained to date.

Results secured have been in forage acres rather than surface acreage. A resume of all data obtained up to 1918 indicates that on the average 0.8 forage acres per head per month are required for cattle, and .01 forage acres per head per day for sheep. Since there is such a large variation in carrying capacity due to various factors entering in, surface acreage data obtained on one area is not usually applicable on another without taking into consideration these factors. It has come to be realized more and more that carrying capacity is a study of each individual area to determine the effect of the various factors entering in, or in other words, determination of forage acreage for each area adjusting the number of stock grazed to this figure and following this up by checks of actual use. Numerous check enclosures have been constructed on various Forests in all Districts, and in many instances quadrats established for use in direct ocular comparisons as well as detailed study to indicate the effect on present grazing use and adjustments needed.

Short articles have been published in various livestock journals and chapter included in Department Bulletin 790 on Range Management.

Further Work: The collection of data by grazing reconnaissance, special inspectors and local officers will be continued. Where practicable, additional special areas will be brought under close observations. Definite plans for such a study on the Wasatch Forest in Utah have been made. Checks of results obtained by actual use will be continued. Special emphasis has been placed on more accurate observations on results of actual use in grazing administration by local officers. Observations and quadrat study of enclosures already constructed will be continued and additional check enclosures will be constructed in all the Districts as time and funds become available, and data secured by local officers and permittees will be reported.

Date of Completion: Indefinite. Carrying capacity will be a problem of importance for many years and therefore must be continuous. Specific studies may be completed and others initiated, but the main study will go on until the normal carrying capacity of all important grazing areas has been determined. This will require careful study followed by years of check by actual use. Therefore, it is a line of work hand in hand with actual grazing administration, supplemented by special studies here and there, rather than a specific study in any one locality.

Assignment: W. G. McGinnies, D. 1; C. K. Cooperrider, D. 3; J. O. Stewart, D. 4, and inspectors of grazing, grazing examiners, and certain administrative men in each District under supervision of Washington and District offices.

GS
Carrying Capacity
Spring-Fall Range
U. S. S. E. S. & G. B. E. S.

Project: The carrying capacity of spring-fall range.

Object: To determine the carrying capacity and forage acre requirement of spring-fall sheep range under different methods of using the range and of handling the stock.

Status: Records are being maintained of the number of sheep and period grazed and degree of utilization at the end of the fall grazing season for the several paddocks, and by camps for the open range where sheep are herded. Intensive reconnaissance of the ten paddocks has been made and such a survey is contemplated for the open range on the Reserve. These records will be correlated to show surface and forage acre requirement for sheep on spring-fall range. Special consideration will be given to effect of climatic conditions upon forage production.

Results: The average requirement for one sheep in the ten paddocks for thirty days was .60 acres per head in 1923 and .71 acres per head in 1924. The range was utilized a little closer in 1924 than in 1923. These figures are very tentative and under pasture handling, which ordinarily gives a higher carrying capacity than under herd.

Further Work: Grazing records will be maintained as in the past two years. At the first opportunity figures for the outside range will be worked up. It is planned to make an intensive reconnaissance of the entire Sheep Station Reserve in the spring of 1925.

Assignment: U. S. Sheep Experiment Station and Great Basin Experiment Station in cooperation.

GS
Carrying Capacity
(Cooperation, Utah Agricultural College)

Object: To determine the proper dates between which the range may be grazed from the standpoint of the requirements of the forage plants and the demands of the stock, and the maximum number of stock the range can consistently support.

Status: Enclosures and quadrats established on Cache Forest 1924.

Further Work: It is proposed that the Agricultural College will build suitable pastures on the Cache Forest and furnish the cattle to graze them under an agreed plan. Observations and records to be kept by Forest Service representative.

Date of Completion: Indefinite.

Assignment: J. O. Stewart and Great Basin Experiment Station, in cooperation with Utah Agricultural College.

Protection.
Grazing, Erosion, and Stream Flow,
G. B. E. S.

Project: The effect of grazing and vegetative cover on erosion and stream flow.

Object: To determine (1) the role of herbaceous and shrubby vegetations in the control of erosion and the regulation of streamflow and (2) the regulation of grazing necessary to maintain adequate watershed protection.

Status: Two small watersheds designated as "A" and "B" at the head of Ephraim Canyon, the former with an area of 11.24 acres and the latter 8.97 acres, were selected and in 1915 equipped with devices to measure amount and rate of fall of precipitation and run-off, and material eroded. The vegetation on both areas originally had consisted principally of grasses and weeds with scattered clumps of wild currant (Ribes spp.) and Mountain elder (Sambucus spp.) with an occasional very small clump of timber, principally alpine fir. Both areas had been badly depleted by overgrazing prior to 1912, and the herbaceous vegetation reduced to a poor stand, consisting largely of pentstemon, (Pentstemon rydbergii), sweep sage (Artemisia ludoviciana) yarrow (Achillea lanulosa) and other species common to this association. The density of the vegetation on "A" was estimated to be .12 and that of "B" .4 at the beginning of the experiment. Dissimilarities other than in vegetative cover occur in topography and drainage system. Area "A" has a main drainage channel traversing the area from end to end with the terrain sloping with it from both sides, while "B" has a slope fairly uniform in direction. The mean gradient of "A" is about 17 per cent and that of "B" about 15 per cent.

Both areas were closely grazed usually about the first of August each year by a band of sheep, from 1915 to 1919, inclusive. The past five years "B" only has been grazed. Grazing was intended to be regulated to hold the density of the vegetation stationary during the periods each area was grazed. Area "A" has been allowed to improve the last five years. Records of amount and duration of precipitation, and amount of run-off and sediment have been obtained for each summer rainstorm since 1915, and for winter snowfall for several years.

As a result of the manner in which the two areas have been grazed, "A" has improved in density of vegetation from .12 in the beginning to .37 in 1923 and 1924, and "B" has remained stationary in this respect. Practically all of the improvement on "A" has occurred during the last five years. The records of precipitation and of streamflow and erosion show that this increase in vegetation has caused run-off to decline over 30% and erosion to decline about 60% over the past five years period. In one storm in 1923 the reduction in run-off and sedimentation was over 66% each, As compared to a storm of similar intensity but of shorter duration in 1919.

Early results were established in Buleetin No. 675, "Range Preservation and Its Relation to Erosion Control on Western Grazing Lands" in 1918.

Further Work: The project will be continued through 1925 as during the past five years, with the possible exception of the introduction of light grazing on "A" depending upon the outcome of further analysis of the data obtained to date. The project should be extended to include a check of conditions past and present, on areas where erosion has been bad in the past, but is now checked by revegetation of the watersheds, and to areas where erosion has not been checked.

Date of Completion: Indefinite.

Assignment: Great Basin Experiment Station.

GS
Protection,
Planting to Check Erosion,
G. B. E. S.

Object: To determine ways and means and the practicability of planting of trees, shrubs, and herbaceous plants to check erosion along water courses where abnormal erosion is taking place, and on denuded lands.

Status: Erosion, including sheet erosion on more or less denuded slopes, "shoe string gulley" erosion, and undue washing along stream courses is occurring at an alarming rate on both National Forest and other lands. Once started, it continues somewhat in the form of a "vicious circle" unless impeded by some means or another. We must recognize overgrazing of watersheds, both past and present, as one of the primary and most important causes. Regulation of grazing on watersheds is therefore of first importance. Once started, however, erosion scars are slow to heal. Reclaiming gullies and stream courses by planting and other means must be recognized.

Planting of various shrubs, including aspen, willow, elderberry, wild currant, etc., were tried out at the Experiment Station for several years after it was established. In each instance tests resulted in failure because of difficulty to propagate the species, and heavy expense.

The planting of Ribes spp. on denuded hill sides was attempted in 1920. Fair results were obtained in getting plants started, but the exceedingly slow spread of the plants and excessive cost renders the use of this plant unpractical, except where the high value of the watershed may warrant heavy expense.

About 1917 terracing of hillsides that were badly depleted of vegetation and were transversed by numerous gulleys, followed by sowing of various tame and native grasses, was tried. Where terraces were made two to three feet wide, and ten to twenty feet apart, and sown to the grass seed, the terraces stopped the erosion and the introduced vegetation reclaimed the hillsides to a very satisfactory degree. It is concluded that this is an effective way of checking erosion but the expense involved in preparing the ground and sowing the seed is so excessive as to render the method uneconomical, except where high or special value of the watershed will warrant such expense.

A test was started in 1920 to determine the effectiveness of sowing native brome grass on an area almost denuded of vegetation, and badly scarred by "Shoe string gulleys." Even with crude methods of planting the seed, remarkable results have been obtained where the seeded area was protected from grazing. The grass gained root along the bottoms of the gullies, and now each gully is a row of grass plants. This method holds out the greatest hopes for planting to check erosion on gullied hillsides.

Further Work: Results in so far as terracing and planting of native shrubs are considered sufficiently conclusive to warrant no further activity along this line, except as a limited number of very promising species may come to light for stream course planting. Work in terracing and planting has been closed. One of the fenced areas where this work has been done will be opened to grazing in 1925, the other will be kept under fence, and the two areas will be maintained in this condition for demonstration purposes.

No other work in this project is contemplated for the immediate future, but the project should be kept active so that it will be open in the event further work of this character may be desired instead of closing it in 1926, as recommended last year.

Date of Completion: Indefinite

Assignment: Great Basin Experiment Station.

GS

Protection, Effect of
Grazing upon Reproduction
of Western Yellow Pine.
D-3

Status: Main study and supplementary study started in 1912. The main study completed in 1915 and report published as Bulletin No. 580 in December, 1917. During 1918 all plots on the Coconino Forest were reexamined and the stakes were re-established in cooperation with the Fort Valley Experiment Station.

The plots will be re-examined periodically for the purpose of ascertaining the percentage of the reproduction originally on the plots when the study was started which eventually develops beyond injury by grazing, and to determine to what extent the new reproduction becomes established. It is possible that the study will need to be continued to find out if the desired amount of reproduction will come in eventually if grazing is continued and, if so, what delay has been occasioned by grazing and the effect of this delay upon the final mature stand of timber, either in quantity or time required to produce it. Therefore, the plots will be re-staked and re-examined as considered advisable by future developments.

Date of Completion: More in the nature of a line of work to secure proper management of stock to eliminate or lessen injury to reproduction.

GS
Protection,
Grazing and Reproduction,
D-2

Status: Two plots were established in yellow pine plantations at Halsey, Nebraska, in the horse pasture, to determine any influence which the grazing of the grass might have on the establishment and development of the yellow pine plants. No appreciable differences are evident, due to grazing.

In cooperation with the Offices of Forest Management and Research and the Pike Forest, project was started on the Pike Forest in 1919 to determine the effect of cattle grazing on planted trees and erosion, and the possibility of overcoming erosion through planting or restricting grazing within the South Platte watershed. Two watersheds were fenced to exclude cattle, one being planted and the other unplanted. Two unfenced watersheds, one planted and the other unplanted, are also under observation.

At the close of the fifth season the average survival in the fenced plots is 40.9% while that of the unfenced plots is 48.3%. Smaller check plots put in in 1921 show 34% and 25% survival, respectively, for the fenced and unfenced areas.

Graphs have been prepared of the readings on grazing quadrats and erosion points made in August, 1919, September, 1920, and October, 1921. These show changes in the density of vegetation, the percentage ratio between the classes of plants, and the number of plants in the various classes.

Plots to study the effect of grazing on reproduction were established during 1924 on representative areas of the main Forest types throughout the District.

Further Work: On the Pike Forest survival counts of seedlings and chartings and observations on grazing quadrats and erosion points will be made every five years. Careful records will be made for the plots on all Forests.

Date of Completion: Indefinite.

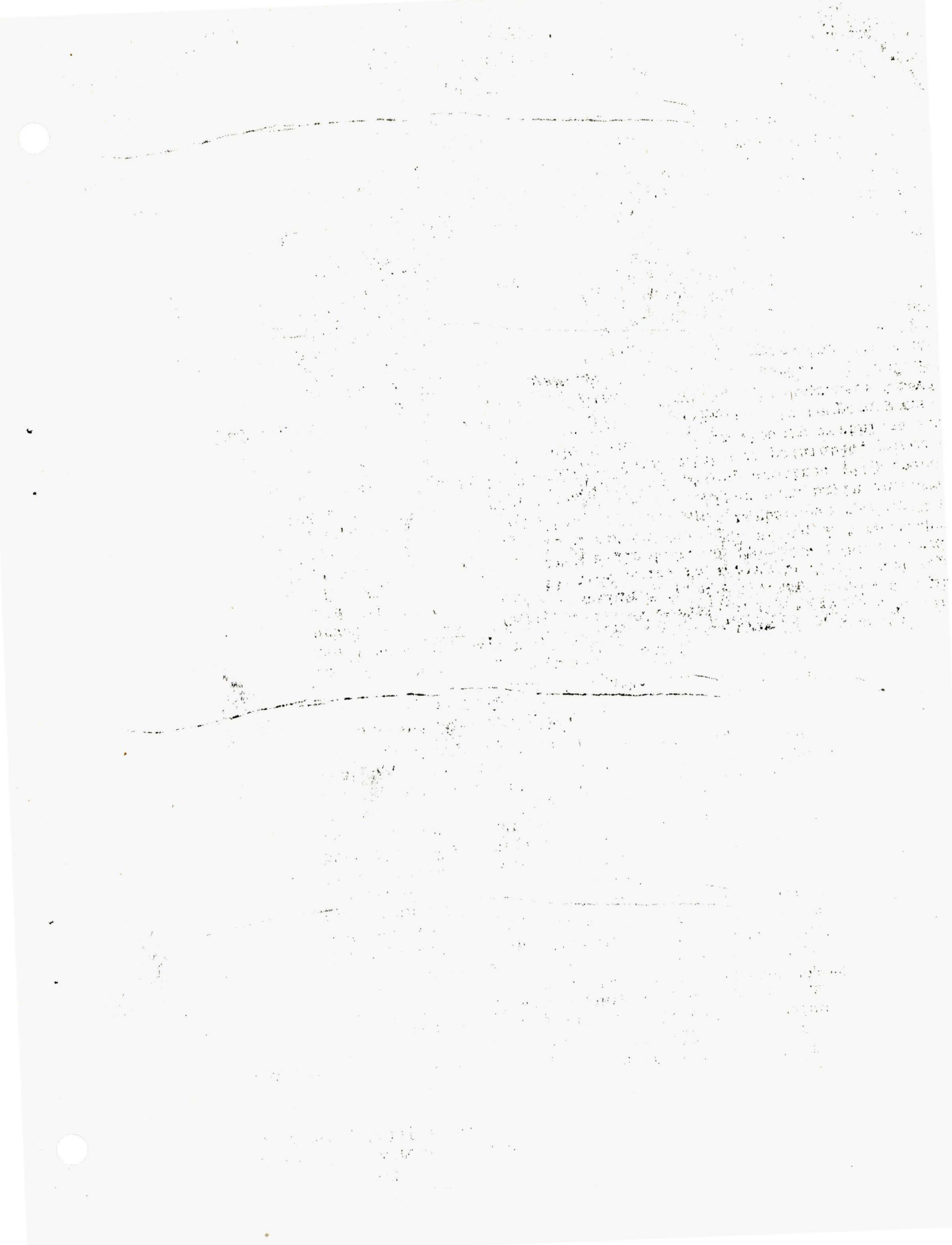
Assignment; Administrative grazing officers of the District in cooperation with the offices of Forest Management, Research, and the local Forest officers.

Protection, Effect of Goat
Grazing upon Range, Timber Cover,
Watershed, and Development of
Improved Methods of Handling Goats.

Status: The results of southwestern intensive investigations, except the effect of goat grazing upon reproduction and the general study on other Forest ranges, were published in Department Bulletin 749.

Further Work: The application of improved methods of management should be extended on Forests and public domain by furnishing information through associations, individuals, and by demonstrations.

Date of Completion: The proposed work as outlined is in the nature of a line of work rather than a project. Consequently the studies will continue until satisfactory methods of management are adopted generally on Forest ranges.



Date of Completion: Indefinite.

Assignment: California Forest and District Office, San Francisco.

GS

Handling Stock,
Improved Methods of Handling
Sheep on Forest Range.

Status: Early work with coyote-proof enclosures on Wallowa Forest 1907 to 1910. Three circulars published on this. Observations on Lewis & Clark, Madison, and Lassen Forests in 1912; study by Grazing Examiner on the Madison Forest in 1913 and 1914; study by a special man on Payette 1912, 1913, and 1914; study by Grazing Examiner on Bighorn in 1913 and 1914. Observations and good results on Madison, Helena, Lewis & Clark 1915-1917. On Ochoco, Wallowa, Whitman, Rainier, Malheur, Wenatchee, Umatilla, California, Lassen Fillmore, Fishlake, Manti, and Servier Forests, new method put into effect, one or two bands carefully studied. Since 1917 aggressive effort made to secure adoption of the bedding-out system on all Forests, and remarkable progress has been made. Deferred and rotation system of grazing being followed on many sheep ranges. General observations continued to determine difficulties and ways of overcoming them. Several articles published in National Wool Grower and a chapter in Bulletin 790. Results now being compiled with the expectation of preparing a manuscript for publication.

Study of coyote-proof enclosures and sheds for lambing started in 1910 on Cochetopa. Forest Service Bulletin 97 published on this work. Considerable increase in lamb crop secured. The results have shown so conclusively to local ranchers the advisability of using similar enclosures and sheds that about 80% of the sheepmen using the Cochetopa ranges lamb with the use of sheds, and many of them have woven wire division pastures to aid in caring for the lambs during the lambing period. Several large sheep producers on the Datil Forest have adopted the improved methods, and improvements based upon the experiments have been adopted by many sheepmen.

Further Work: The bedding-out system of handling sheep has passed the experimental stage. Approximately 70% of all sheep on the National Forests are now handled according to methods approaching this system as advocated by the Forest Service. Continuous effort will be made to secure the adoption of this method by the remaining 30% of sheep owners, and to perfect a system of handling all sheep to more nearly approach the ideal desired. Additional demonstration tests under careful supervision may be necessary. Aggressive effort is being made to extend the use of the deferred and rotation system of grazing to all sheep ranges.

Continued efforts will be exerted to secure application of better lambing methods. A publication covering all phases of handling sheep on the range will be gotten out as soon as possible. A new publication will be prepared covering coyote-proof pastures in sheep management to bring information down to date and replace previous publications the editions of which are exhausted.

Date of Completion: Continuous until satisfactory methods are adopted on all National Forests.

Assignment: Forest officers administering grazing under the general direction of District and Washington Offices.

GS
Handling Stock
Improved Methods of
Handling Cattle on
Forest Range.

Status: Observations have been made on a number of Forests to determine the best methods of management of cattle on the range, particularly to secure proper distribution of stock on the ranges with reference to watering places, location of forage, and seasonal use of the range. Very favorable results have been obtained, especially on the Sierra, Whitman, Ochoco, Okanogan, and Uinta Forests, largely through proper salting, development of more watering places, and riding. For many Forests detailed salting plans have been developed, control of fences and stock trails have been constructed, and permittees are giving their stock more attention. On the Uinta and several other Forests in District 4, the time of grazing of different slopes and at different altitudes has been satisfactorily worked out through salting and riding. Observations on salting away from water to secure better distribution have been made on the Santa Rita Range Reserve in Arizona. The results have been more even and proper seasonal use of the range, greater carrying capacity, smaller losses of stock, increased calf crop, and the production of better beef. Salting plans are being developed for a large number of the Forests in all Districts but much still remains to be done before proper distribution of cattle on the range will be secured.

A study of salting practises was initiated in District 3 in 1921, and a bulletin manuscript has been presented for publication covering this work as well as other salting methods throughout the west.

A study of all phases of handling cattle on rough, brushy ranges was initiated in 1920 on the Chiricahua Division of the Coronado Forest. Additional water developments, salting places, control fences, and cleared trails through the brush have been established. Detailed quadrat and general observations are being made each spring and fall.

Results of the early studies were incorporated in a chapter of U.S.D.A. Bulletin 790 on Range Management, and several articles published in the livestock journals.

Further Work: The study on the Coronado Forest will be continued under more intensive methods. A more thorough investigation of salting practises will be made on the Santa Rita and Jornada Range Reserves. General observations of improved methods of handling will be made on many Forests and reports submitted. Greater effort will be made to secure wider application of methods already worked out on various kinds of range.

Date of Completion: Indefinite.

Assignment: W. R. Chapline, Matt J. Culley, J. D. Schoeller, and Forest officers administering grazing under the general direction of District and Washington offices; M. W. Talbot (now of the Bureau of Plant Industry) until publication of bulletin.

GS

Handling Stock, Management to Avoid Loss.

Object: To determine the best means of preventing losses caused by starvation, diseases and other causes which materially affect the cattle business in the Southwest, so that such limiting factors may be eliminated from the industry in so far as is possible.

Status: On the Reserves the minimizing of losses has resulted largely from providing sufficient feed, giving adequate care, and close culling of aged cows, vaccinating for blackleg, and giving such other attention to diseases as was practicable. Attempts to hold old cows and to excessively use range seriously infested with loco are followed by serious losses when feed wanes.

In 1922 the Jornada Range Reserve in southern New Mexico experienced the worst drought and greatest shortage of feed so far experienced since 1915 when the Forest Service took over the investigations. Over 650,000 cattle were moved from New Mexico during the year, and all cattle had to be moved from many southern New Mexico ranges. The 4.4% loss on the Jornada in 1922 from all causes exceeded the 3.5% loss suffered during the drought of 1918, but that loss compares with losses on other similar ranges of 25% to 35% and in some cases even higher. The loss was prevented from being greater by reserving some range forage for the critical period of the year, supplemental feeding of cottonseed cake, early weaning, and removal of calves, and the keeping of the number of stock on the range as near the actual carrying capacity as was practicable. The management of the Reserve has been placed on the basis of where 50% of the number of stock which may be carried in good years is carried as breeding stock, which may be held over the drought with only careful culling of stock. The balance of the carrying capacity in good years is used by steers or other stock which can be disposed of readily when drought conditions decrease to the volume of feed available. Losses have been kept down in all years by the feeding of cottonseed cake during the winter and spring to poor cows, bulls, and many calves.

During the drought of 1917-18 the grinding of soapweed was placed on a practical scale and more than 1,000 poor cows were fed soapweed and cottonseed products on the Jornada Reserve, saving probably 500 head from starvation. U. S. D. A. Bulletin 745, giving the results of this work, was published. Soapweed also proved satisfactory as ensilage, while Tobosa grass did not. In the spring of 1921 on the Santa Rita a large number of stock were saved from starvation by feeding Cholla after spines had been removed by burning.

The results of the work on the Jornada Reserve were published in Bulletin 588, and more recent results in a chapter in Bulletin No. 1031. The results of the investigations on the Santa Rita Reserve are being prepared for publication.

The most striking results are that the average loss on the Jornada for ten years, including seven dry ones, has averaged 1.6% or about one-fifth of the average loss on similar ranges of southern New Mexico. On the Santa Rita where six out of the last ten years have been dry, the average loss has been about 3% or about one-third of the average loss on similar ranges of southern Arizona.

A Farmers' Bulletin on saving livestock from starvation on southwestern ranges, by C. L. Forsling, was published during the year.

Further Work: It is planned to continue with the investigations along the above lines. Work will be intensified as far as seems practicable under management on large range units.

Date of Completion: Continuous as long as the Reserves are under experimental management.

Assignment: Matt J. Culley, Santa Rita Range Reserve; and J. D. Schoeller, Jornada Range Reserve.

GS
Handling Stock
Increase in Calf Crop

Object: To determine the factors which influence the production of calves in the Southwest so that improved methods of management may be worked out which will result in increasing calf crops.

Status: Factors affecting calf crop have been carefully studied and the best principles applied in the practical management of large herds in so far as possible, both on the Santa Rita and Jornada Range Reserves. The results have been a calf crop 15% to 25% greater than in other range cattle outfits on similar range. During drought years the calf crop on the Reserves has often been several times as large as some individual outfits experiencing similar drought conditions. On the Jornada Reserve the nine year average of the general herd has been approximately 65%; while the special herd, with better care, has been nearly 76% for seven years. These averages includethe effects of seven dry years. The largest calf crop so far received from the large special herd has been 88.8% in 1921.

The eight year average through 1923 for the Santa Rita has been approximately 73%, though one outfit averaged nearly 80%, and in 1920 secured a calf crop of 88.5%. From a small special herd of 30 cows the calf crop in 1922 and 1923 averaged 89.3% and 92.3%, respectively. These results have been secured largely because the cattle are provided with plenty of forage, water, and salt; sufficient bulls are used; adequate distribution of bulls is made; and more attention is given to potency and vigor, gentling cattle, age of breeding stock, separating breeding and non-breeding stock, and management in general.

A chapter outlining the early results on the Jornada was published in Bulletin No. 588, and the more recent results in Bulletin No. 1031. The results of the investigations at the Santa Rita are being prepared for publication.

Further Work: Careful observations and additional tests will continue to be made at both Reserves to determine more definitely the influence of the different factors affecting calf crop.

Date of Completion: Continuous during the period that the Jornada and Santa Rita Range Reserves are under experimental management.

Assignment: Matt J. Culley, Santa Rita Range Reserve; and J. D. Schoeller, Jornada Range Reserve.

GS
Handling Stock,
Improvements in Grade.

Object: To improve the general grade of range stock through improved methods of breeding so that the cattle produced will develop better and approach more nearly to the color, conformation, and type of the beef breeds used, with the ultimate object in view of obtaining better prices for a product which is more uniform and supplies a better demand.

Status: On the Jornada Range Reserve purebred bulls only have been used since 1915. In that year a special herd of 500 selected cows and bulls were segregated from all other stock. The number in this herd was cut down as a result of the drought, and it was also re-selected in 1919. More recently both the special herd and the general herd on the Reserve were run together. Special effort has been exerted in the culling of old and undesirable cows and in the selection of bulls and young heifers to replace cows. While drought affected the size to a certain extent, the results have shown in the improvement in steers from the Reserve, which have brought prices $2.50 to $5.00 more per head at various times than steers of the same age from herds on the outside range. Further, some yearling steers were of such quality that they sold along with 2-year-olds at 2-year-old prices. Results of the investigations have been published in chapters in Bulletins 588 and 1031. The top carload of calves weaned in 1923 from the Reserve weighed 465 pounds and sold as feeders for 6 cents per pound. Less a 5% shrinkage they brought $26.49 per head at the ranch. This compares with 50 carloads of steers from the same region, the majority of which were two's and up, which averaged approximately 579 pounds and sold for between 4 cents and 5 cents per pound or $26.78 per head. Fifteen carloads of weaned calves from the region averaged 322 pounds per head, 6 cents per pound, and $19.32 per head. This shows a difference in net price of but $7.46 per head in favor of the older steers, though the majority of them were cut 25% to eliminate undesirables. In the fall of 1924, 100 selected heifer and steer calves sold for $22.50 each.

At the Santa Rita Range Reserve similar investigations were begun in 1915 and have shown just as marked progress. During 1923 one bunch of 32 yearlings averaging 595 pounds sold at 5 cents for $29.75, another bunch of 8 yearlings and 14 two's weighing 725

pounds each brought $36.25, and 91 yearlings from one other herd brought $24.00. One bunch of cows averaging 850 pounds were sold for $34.00 per head. 1924 spring sales included 98 head of yearling steers averaging 622 pounds and selling for $31.10 per head. Sixty-eight head of 6-months calves weighed 338 pounds and brought $20.28, or only $2.00 under the average price of yearlings from this section of southern Arizona. 1924 fall sales included six cars of cows at $35.00 a head, and two cars of calves at $22.00 a head, while m most cattle of the region were being forced on the market at ruinous prices.

The reasons for this have been largely the use of good purebred bulls, close culling of cows, careful selection of heifers, good feed, and the feeding of supplements when necessary.

Further Work: The investigations under way will be continued, and still greater care will be exercised in the selection of bulls, culling of old animals, and the replacement by selected heifers.

Date of Completion: Continuous during the periods that the Jornada and Santa Rita Range Reserves are under experimental management.

Assignment: Matt J. Culley, Santa Rita Range Reserve; and J. D. Schoeller, Jornada Range Reserve.

GS
Handling Stock,
Costs.

Project: To determine the relative cost of producing stock under pasture and improved methods of management as compared with the cost on open range.

Status: The analysis of the record of cost of operation on the Jornado Range Reserve for ten years show that with values as nearly as they can be determined at the present time it costs approximately $9.91 a year to carry each cow, which makes a short yearling cost $15.99 without interest when the calves raised number 62 per hundred cows. With interest, the cost per head for the same number raised is $21.68.

At the Santa Rita Range Reserve considerable data are available and have also been analyzed this year. More checking and analysis will be necessary before final conclusions as to the cost of production or the influence of different factors can be determined.

Further Work: Careful records will be kept as to the cost of different phases of producing cattle on the Jornada and Santa Rita. Similar data will be collected as far as practicable for outside range conditions.

Date of Completion: Continuous during the period the Jornada and Santa Rita Range Reserves are under experimental management.

Assignment: J. D. Schoeller, Jornada Range Reserve; and Matt J. Culley, Santa Rita Range Reserve.

GS
Handling Stock, Jornada,
Range Feeding (Cooperation
New Mexico Agricultural Ex-
periment Station)

Object: To determine the amount of concentrate (cottonseed cake) necessary to feed, in order that such feeding may be of real value to the cattle and at the same time be economic.

Status: This project was started in Pasture No. 7 of the Jornada Range Reserve on October 22 through a cooperative agreement between the A. H. Dept. of the State Agricultural College, the cooperator, and the Forest Service. Fifty head of short yearling heifers, divided into five lots of ten each are being used. One lot of ten is not being fed. The other four lots are fed ½, 1, 1½, and 2 pounds of cottonseed cake per head per day, respectively.

The pasture in which the herd is being carried has an area of 1450 acres, which is equivalent to 29 acres per head yearlong, or 58 acres per head for 6 months. It is made up of three types; black gama, mixed grass, and black brush-creosote brush. This pasture has been deferred for a period of 6 months including the growing season and received during the latter period 4.26 inches of precipitation which is .5 inch below the mean seasonal for 50 years. Considering the drought conditions that have prevailed during the past three years, the pasture is in fairly good condition. It would, however, easily carry the number of stock now using it without feeding for the 5 or 6 months of the experimental feeding period.

Further Work: If possible, the College is in hopes of carrying on this experiment over a period of three or four years with the same animals, if arrangements can be made to pasture the stock. Naturally, the results over a period of years will be more conclusive than a one-year trial.

Assignment: Jornada Range Reserve in cooperation with New Mexico Agricultural Experiment Station.

GS
~~Handling Stock~~
Herding vs. Pasture
Spring-Fall Range
U.S.S.E.S. & G.B.E.S.

Project: Herding vs. the pasture method of handling sheep.

Object: To compare the carrying capacity and relative cost of handling sheep in pastures as compared to herding on spring-fall range.

Status: Nothing has been done on this project to date except to obtain data for grazing of the ten sheep paddocks. As soon as feasible it is planned to fence sheep tight, the area south of the Camas-Meadows road, where a small band of sheep may be grazed under the pasture method for comparison with the open herding method.

Assignment: U. S. Sheep Experiment Station and Great Basin Experiment Station in cooperation.

GS
Poisonous Plants

Project: Eradication of poisonous and unpalatable plants from the range, all Districts.

Status In 1913 minor tests in the eradication of tall larkspur by grubbing were initiated on the Forests in California. In 1913-14-15-16- the test was enlarged until, in 1915, grubbing out 68 acres was undertaken on the Stanislaus Forest. Eradication was approximately 95 per cent effective, and losses of livestock were reduced below the average losses in preceding years, sufficient to coverr the cost of eradication. Eradication of tall larkspur by grubbing has passed beyond the experimental stage and has been extensively done on a great many Forests in Districts 1, 2, 4, 5, and 6. Up to and including 1922 larkspur had been eradicated from a total of over 7,250 acres, at an average cost of less than $5.50 per acre. An additional 8,300 acres where larkspur was in small amount have been cleared at about 20 cents per acre. The total cost of larkspur eradication through 1922 has been $38,267, over one-half of which was paid by interested stockmen. The estimated annual reduction in loss of stock as a result of this work has beem over $65,000. With few exceptions, the value of the stock saved as a result of the eradication work has been sufficient in one year to cover from one-third to two times the cost of eradication. Report on eradication of tall larkspur by grubbing published in Farmers' Bulletin 826, 1917. This will be revised and brought up to date in the near future.

At the Great Basin Experiment Station studies on an experimental basis showed that cutting above ground four times during a period of three years is the cheapest way of eradicating tall larkspur on areas relatively free from rock, brush, and timber. This method should be tried out on a practical basis to secure a comparison of costs with effectiveness of grubbing before the cutting method is finally advocated for use under practical range conditions. Tests were made with a number of chemicals in 1924.

On the Deschutes Forest in Oregon experimental eradication of water hemlock at an initial cost of $4.83 per acre with minor amount of eradication in following years gave better distribution of stock and eliminated an annual loss of cattle greater than the total cost of eradication.

Studies have been made in District 3 of the possibilities of eradicating loco by grubbing and of reduction of losses from loco poisoning by change in the method of range management and the time of grazing. On several areas, eradication has been 90% to 95% effective and apparently has proven practicable from an economic standpoint. Results in grubbing loco on the Pike Forest show no advantage in grubbing at any particular time of the year, and that a single grubbing is ineffective and re-grubbing for several years to eliminate new seedlings is necessary if any benefit is to be secured from grubbing.

An additional study has been devoted to eradicating death camas and sneeze weed.

Further Work: Eradication of tall larkspur by grubbing will be continued as a range management project in cooperation with with stockmen, as fast as funds are available until losses of livestock from this cause within practical possibilities has been eliminated. As soon as it is feasible to do so, a practical demonstration of eradication of tall larkspur by cutting, in accordance with plans developed by the Great Basis Experiment Station, will be undertaken. A study of methods for eradicating low larkspur will be undertaken in District 1 this year.

Regrubbing of the loco plots on the Pike will be continued. A thorough test of all possible methods of eradication will be made on the Santa Rita Range Reserve.

Observations on eradication of other poisonous plants and management of areas infested will be continued and if the conclusions appear to warrant it, further investigations will be initiated as soon as funds and men are available.

Date of Completion: No further investigations as to methods, cost, etc., will be done with grubbing tall larkspur, since it is believed that methods are sufficiently standardized to obviate the necessity for further special study. Work on other poisonous plants will continue as men and funds are available until satisfactory means for controlling the poisonous plants on Forest ranges have been worked out.

Assignment: W. G. McGinnies, District 1; Matt J. Culley, Santa Rita Range Reserve; and Forest officers administering grazing under the general direction of District and Washington offices.

GS
Water Development.

Project: Number, distribution, and cost of watering places on cattle ranges of the Southwest.

Status: Farmers' Bulletin No. 592 was published in 1914 as a result of the general study of possibilities of water development on all National Forests.

In District 3 observations of water distribution and methods of developing water on the National Forest ranges have been made over a period of three years with a view to formulating effective methods of water development and effective distribution of watering places to secure maximum utilization of the range consistent with the difficulty and cost of water development. A publication by Mr. M. W. Talbot covering this work will be issued during the year, Dept. Bull. 1358.

During the past ten years careful studies have been made at the Jornada and Santa Rita Range Reserves to determine the distance that permanent watering places can be apart and still secure reasonably efficient utilization of the range. To supplement such existing permanent watering places numerous small tanks have been constructed at the Jornada Reserve, and one such on the Santa Rita.

It is found that where conditions are favorable to the construction of tanks for accumulation of water to be used during a portion of the year to supplement more permanent supplies, the money spent for such water development is a good investment. This supplemental water results in better distribution of the stock, more equal utilization of the range, more succulent feed, less waste of energy in travel by the stock, and the possible protection of range around permanent waters for use during critical periods when the temporary watering places go dry.

Further Work: The investigations at the Jornada and Santa Rita Reserves will be continued to determine the influence of the factors affecting water development and its true value in range management. Methods of developing water and costs, especially of tank construction, will be further observed. The observations on National Forest ranges will be continued.

Date of Completion: Will be continued on the two Reserves as long as they are under experimental management.

Assignment: Matt J. Culley, Santa Rita; J. D. Schoeller, Jornada; and M. W. Talbot (now of Bureau of Plant Industry) until publication of bulletin.

GS

Range-Destroying Rodents

(Cooperation, U. S. Biological Survey)

The kangaroo rat eradication work which was carried on during the past summer on the Jornada was handled entirely by the U. S. Biological Survey under the direction of R. H. Miller, Junior Biologist.

A crew of five men on horseback covered 78,000 acres in approximately fifty days at a cost of $.0193 per acre. It was estimated that a total of 204,211 rats were exterminated, averaging 3.21 rats per acre. The cost per rat being $0073. Several formulas for poisoning the grain were used, but the most effective and economical one was found to be a 1 to 30 mixture of Strychnine (standard formula) used on steam-rolled oats.

The type of range most generally covered in this work was black grama, although considerable of the mixed grass type and sand-hill type were also covered. Both the grama and mixed grass types as well as the sand-hill type on the Reserve seem to be the most favored haunt of the kangaroo rat, probably because of the character of both soil and grass which is apparently well-suited to their habits.

Three species of rats were found to exist on the Jornada; (Dipodomys spectabilis, D. marrimai, and D. ordii). Two of these live by means of harvesting and storing up both seed and grass, the third lives by robbing the other two.

The kangaroo rat not only reduces the carrying capacity of a range by consuming and storing seed and grass, but causes the potential carrying capacity to be reduced by devastating and the denuding of the area around his den which is a factor in hastening the ultimate destruction of a range, particularly when it is being constantly overgrazed, as is the case on much of the public domain.

On the Jornada it was estimated that the kangaroo rats reduced the annual carrying capacity of the area covered by eradication fully 6% and a further reduction of 1/2 per cent has taken place by a reduction in the area capable of producing forage. In the past nine years Pasture No. 2 has carried an average number of 613 head of stock yearlong, equivalent to 60 acres per head.

Having this as a basis, since this pasture is typical of the 78,000 acres poisoned, the value of the carrying capacity on the area covered has amounted to $241.00 per year figuring grazing at $1.50 per head. This means that over the past nine years the carrying capacity has been cut approximately 161 head yearly or equivalent to the loss of a pasture containing approximately 9700 acres.

The work already done, however, will not assure the Jornada of the increased carrying capacity in the future of 161 head because there remains a considerable remnant of the rats which are increasing as time goes on, and unless the area is covered again the coming summer, it will not be long before the same conditions will exist as in the past.

Further Work: Careful observations will be made of the recovery of the affected range, and further damage from the remaining rats.

Assignment: Jornada Range Reserve in cooperation with Biological Survey.

GS

Utilization and Management
of Bunchgrass Range.

Project: Utilization and management of bunchgrass range in the Southwest.

Object: To determine the carrying capacity, proper time of grazing, revegetation requirements, and methods of handling stock on bunchgrass range.

Status: There are extensive areas of coarse bunchgrasses, largely Festuca arizonica and Muhlenbergia gracilis, in the Forests of the Southwest of which the true grazing value is not known. These grasses usually attain rank growth and are tender and highly palatable in the spring, becoming somewhat dry and coarse later in the season as the seed crop matures. When green they furnish excellent feed, but as they mature there appears to be a corresponding decrease in palatability and it is evident that the completeness with which they can be utilized without decrease in gain of stock and possible injury to the range itself is not as great as for many other grass species. The problem is to determine what is proper utilization from the standpoint of both stock and range, and consequently the true carrying capacity and methods of handling stock and range to secure this use.

Observations were made on three pastures on the Apache Forest in 1914 and 1915 and report submitted. General observations have been made on the Coconino and other Forests. An examination was made on the Apache in 1920. Valuable data as to the value of the bunchgrass range for cattle has been secured but results are by no means conclusive.

Further Work: This is an extremely important project demanding immediate attention. It cannot be satisfactorily carried with present personnel and funds. The bunchgrass range on the Apache will be examined from time to time and observations will be made on other Forests in District 3. Range improvements, particularly fences to control the stock, are essential to successfully study this problem, and the progress made will depend upon the rapidity with which the necessary improvements and control of stock are secured, and the time of one man available, for special study. As soon as funds become available, a typical controlled unit should be placed under intensive study.

Date of Completion: The study will continue until point of satisfactory utilization of bunchgrass is determined and improvements planned that will secure this utilization.

Assignment: C. K. Cooperrider and local Forest officers in District 3.

GS

Utilization and Management of
Browse Range, G. B. E. S.

Object: To determine for browse range (1) the suitability of browse range for cattle, (2) carrying capacity, (3) period of use, (4) natural revegetation requirements, (5) value as protection for watersheds and (6) standards of utilization.

Status: A group of cattle have been grazed during the summer season for four years on a selected area of browse range where Gambel oak constitutes 32.4 per cent of the vegetation, serviceberry, (A. rubescens) 19.6 per cent, birchleaf mahogany 13.8 per cent, sagebrush 11.6 per cent, various other shrubs 6.5 per cent, and weeds and grass 15.7 per cent. Each individual animal was weighed at frequent intervals and notes on utilization obtained at each weighing. Records of calf crop, etc., have been maintained.

Four years grazing by cattle on this range indicates that to graze on basis of securing fair use of the oak will result in injury, and probably eventual killing out of the palatable herbaceous plants and shrubby plants more palatable than oak. Forced use of oak may even result in a killing of this species.

Use of the range on the above basis affords little more than a maintenance ration for dry stock after the better species have been utilized, and cows with calves will lose in weight. Growth of range stock older than calves is so slow that they are unprofitable and only a small percentage of the breeding cows reach a condition to breed, so that the calf crop is very low and calves are dropped at the wrong time of year.

On steep slopes or on compact soil use on the basis of the oak forage is very likely to result in serious erosion.

Stocking on the basis of the herbaceous vegetation and the more palatable browse, together with that portion of the less palatable species such as oak that the animals will take incident to the use of the other species seems to be the best practise for the use of browse range from the standpoint of both range conservation and economical livestock production.

Further Work: In 1925 the number of stock will be reduced to 20 head. In so far as possible only cows of breeding age will be used. The same animals will be used each season so far as is practical. Weighings will be made at entrance of the stock on July 1, September 1, September 15, October 1, and on the date of removal. Utilization data will be obtained on each weighing date. Quadrats and plots will be recharted in 1925.

Assignment: Great Basin Experiment Station and Ranger E. V. Storm.

GS
Utilization and Management of
Browse Range, D-3.

Object: To determine the proper management of southwestern browse range involving (1) suitability of use, (2) class of stock to which adapted, (3) carrying capacity, (4) grazing period, (5) requirements for revegetation, (6) effect of grazing on erosion and timber reproduction, and (7) standards of utilization.

Status: There are extensive areas of browse range throughout the Southwest which have generally been overgrazed for many years. Three one-acre areas on representative but overgrazed browse types on the Tonto Forest were fenced in 1920 as a part of the Natural Revegetation project. Quadrats were established and typical browse plants tagged. Records were taken in 1920, 1921, and 1924. Several experimental cattle allotments on the Tonto and one on the Crook Forest were placed under intensive observation during 1924. The following tentative trends are shown:

1. Curley mesquite (Hilaria berlangeri) increased as much as 215 per cent in density under protection from grazing in four years. On a steep slope the increase was 127 per cent. With good growing conditions increase in density is rpaid through extension by stolons. Under excessive overgrazing and drought the density decreases very rapidly.

2. Hairy Grama (Boutelona hirsuta) increased under protection in spite of severe drought conditions but decreased under drought and overgrazing.

3. All browse species show good growth under protection even during the drought and in most instances show recovery from the former severe grazing.

4. Grasses, particularly those with stolons, if allowed to become established, play an important role in retarding erosion.

Further Work: The investigations on the Tonto and Crook Forests will be intensified during the year, and the work will be coordinated with that which has been under way on the Coronado Forest for several years.

Date of Completion: Main work about 1927.

Assignment: E. W. Nelson, C. K. Cooperrider, and M. J. Culley.

GS
Management of Cut-over Areas
D-6.

Object: The object of this project is to determine the essentials for the formulation of the constructive grazing practise which will insure for logged-off lands in the Pacific Northwest (1) adequate reforestation, (2) reduction of fire hazard, (3) profitable returns from grazing. It will, therefore, include studies in (a) natural revegetation, (b) artificial reseeding, and (c) grazing management, and for convenience is grouped as one special project.

Status: To date the study has been conducted largely as a survey of the situation, giving particular consideration to the results obtained in seeding and utilization of cut-over areas owned by a number of large lumber companies. Experimental areas selected on the Columbia, Wenatchee, Crater, Siskiyou, and Santiam Forests, and investigations started. The seeding work on the Santiam was lost through a destructive fire.

Further Work: The main part of the investigations will be concentrated on the Columbia Forest and handled in cooperation with the Northwest Forest Experiment Station. The investigations on the Wenatchee and Crater Forests will be continued in cooperation with the Office of Forest Management and technical personnel assigned to the Forests. When the cutting operations on the Cascade Forest have reached a stage where grazing use is advisable, the experiments will be extended to that Forest, probably in cooperation with the Oregon Agricultural College Experiment Station. A limited amount of time will be devoted to a study of the economic phases.

Date of Completion: Indefinite.

Assignment: D. C. Ingram, in cooperation with the Northwest Forest Experiment Station, Oregon Agricultural College Experiment Station, the Office of Forest Management; technical Forest officers assigned to the Wenatchee and Crater Forests.

GS
Cooperation,
Montana Agricultural College Experiment Station,
(Range Sheep Management)

Object: To study management of sheep on National Forest ranges, correlated with winter feeding and other yearly operations.

Further Work: The Montana Experiment Station will graze the Station herd of sheep during the summer period on a selected allotment of the Gallatin National Forest. The sheep are wintered in the Gallatin Valley. The Forest Service will make an intensive management plan by grazing reconnaissance for the allotment and will keep a record of the range phases of the project. The Experiment Station will handle the animal husbandry phases.

Date of Completion: Indefinite.

Assignment: W. G. McGinnies in cooperation with Montana Agricultural College Experiment Station.

GS
Cooperation,
U. S. Range Livestock Experiment Station.

Object: To assist in the range investigative work to be undertaken at the Experiment Station.

Status: The area was covered by intensive reconnaissance by members of the Forest Service in 1924.

Further Work: A general period study will be made on the range next spring. Further cooperation is dependent on the funds available.

Date of Completion: Indefinite.

Assignment: W. G. McGinnies in cooperation with Bureau of animal Industry and other cooperating organizations.

GS

Exhibits and Illustrative Material for Educational Purposes.

Project: Preparation of exhibits and illustrative material for educational purposes.

Object: To disseminate information relative to principles developed in range investigations in a more popular and effective manner than is had with Department Bulletins and formal reports.

Status: Beginning in 1918 lantern slides, charts illustrated in natural color, wall charts, lectures, popular articles, and fair exhibits have been prepared on the work at the Great Basin Station. This material has been used in lectures before livestock meetings and college students, at fairs, and published in various periodicals throughout the western Districts. An exhibit has been shown each year at the county fair near the Great Basin Station.

For several years certain exhibits have been prepared illustrating improved principles of range management, especially for the Pacific International Livestock Exposition at Portland, Oregon, the International Livestock Exposition at Chicago, and several State Fairs. Last year the Forest Service took an active part in developing the Deaprtment Exhibit on Range and Livestock management for use on the Western Fair Circuit. An exhibit illustrating deferred and rotation grazing was prepared by Public Relations of D-4 in collaboration with the Great Basin Station.

A general range management lantern slide lecture was also prepared on "Range Management on the National Forests."

During 1924 a field demonstration lasting two days was held at the Great Basin Station, and was attended by an aggregate of 125 stockmen and Forest officers.

During the year the District 3 Supervisors held a meeting at the Santa Rita Range Reserve, and the County Agents of New Mexico visited the Jornada Reserve.

Members of the Forest Service attended the extension conferences in a number of western States and assisted in developing the State Extension programs.

Further Work: Effort will be made, in cooperation with Public Relations and the Office of Exhibits and other interested organizations, to work up exhibits for use at the State and other Fairs, livestock expositions, and meetings. A model showing the effect of grazing on erosion and streamflow will be worked up in the near future as well as exhibits covering several of the other important range management projects. Additional lantern slide lectures covering specific phases of range management will be prepared.

Use of Results: The illustrative material will place before stockmen and others interested in range management the results of the investigative work in a papular manner and should assist in obtaining the application of better range management on western ranges.

Date of Completion: Continuous.

Assignment: Great Basin Experiment Station, Range Reserves, special investigative men, District and Washington offices of Grazing in cooperation with office of Public Relations in Forest Service, Office of Exhibits in the Department, and other interested agencies.

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